2.2.5.1
~~2.2.5.2~~

Ohlendorf, Harry/SAC

From: Heinle, Don/SEA
Sent: July 18, 2000 6:34 PM
To: Williams, Wendy/SAC
Cc: Ohlendorf, Harry/SAC; Winstanley, Dan/SEA
Subject: amen outline 718.doc

sect. 3
Not reviewed

amen outline 718.doc

Here are today's additions to my sections of the Eco RA.
I will send the remainder of what I am working on later tonight. Five tabels cited in section 3.2.1.3 will follow shortly as soon as I review changes. The rest will be later.
Don

- Aquatic Plants **(Don)**
- Lowest toxic concentrations of total cadmium, copper, lead, and zinc to aquatic plants are shown in Table 3.2.1.1-1. Plants are more susceptable to copper than aquatic animals are, but sensitivity to the other metals is similar.
- Amphibians **(Don)**
- (LISA)
- Terrestrial Plants **(Brad)**
- Soil Invertebrates **(Brad)**
- Microbial Processes **(Brad)**
- Birds and Mammals **(Brad)**

3.2.1.2 Site-specific Ambient Media Toxicity Tests

- Fish **(Don)**

Site-specific toxicity tests have been done in the CdA basin (typically in the SFCDR). These studies provide important information on the toxic effects that have been observed in site-relevant organisms in site water. These organisms have been exposed under water quality conditions that are by definition appropriate for the site water body (at least under the conditions sampled). Several site-specific acute lethality tests have been did with salmonids (EVS 1996a, 1996b, 1997b; Dames and Moore, 1989; Hornig et al., 1988; Woodward and Farag, 1995; Woodward et al., 1999) and invertebrates (EVS, 1996b, 1997b, 1998; Dames and Moore, 1989). Site-specific data of benthic communities have also been collected (Stokes and Ralston, 1972; Savage and Rabe, 1973; Dames and Moore, 1989). These tests are summarized in the subsequent sections and evaluated with respect to deriving TRVs.

3.2.1.2.1 Acute Lethality Testing with Salmonids

EVS (1 996a, 1 996b, 1 997b) did toxicity tests using water collected from various locations in the SFCDR. EVS (1 996a) observed 44% mortality in hatchery-reared rainbow trout exposed to 10% Canyon Creek water (water hardness not given) and 47% mortality in hatchery-reared rainbow trout exposed to 100% SFCDR water collected near Wallace (water hardness not given).

EVS (1996b, 1997b) also observed mortality in hatchery reared cutthroat and rainbow trout exposed to Cd, Pb, or Zn individually in water collected from the Little North Fork (LN F) of the SFCDR (hardness 18-21 *mg/L*). All three metals were acutely lethal to both trout species at relatively low total metal concentrations (Table 3.2.1.2-1). When normalized to a hardness of 50 mg/L, 60-86% mortality was observed at Cd concentrations between 1.25 and 2.25 µg/L, 20-40% mortality was observed at Pb concentrations between 65.5 and 273 µg/L, and 30-35% mortality was observed at a Zn concentration of 132 µg/L. With respect to Cd, acute lethality (60-86% mortality) was observed in salmonids exposed to Cd (added to site water) at Cd concentrations predicted to be protective of aquatic life (EPA, 1996).

Dames and Moore (1989) did a series of acute toxicity tests *in situ* with site water collected from various locations on the SFCDR and the NFCDR with rainbow trout. Fish were exposed in cages to 100% site water. Water hardness values ranged from 18 to 168 mg/L over three testing periods In all tests did with site water collected from the SFCDR, Dames and Moore (1989) observed 100% mortality after the 96-hour exposure period (Table 3.2.1.2-2). Fish exposed for 96 hours in the NFCDR (a field and cage control) had *30-55%* mortality after 96 hours of exposure. Fish exposed in the NFC DR did not show external signs of metal induced stress, which was observed in fish exposed in the SFCDR (e.g., loss of equilibrium, gill discoloration, excess gill mucous), but did show excessive scale loss indicative of physical trauma within the cage, possibly resulting from high water velocities in the NFCDR (Dames and Moore, 1989). Metal concentrations in the SFCDR associated with 100% mortality (normalized to a hardness of 50 mg/L) were between 2.26 and 7.88 µg Cd/L, 5.4 and 13.1 µg Pb/L, and 857 and 1470 ug Zn/L (Table 3.2.1.2-3). Since the Cd and Zn concentrations but not the Pb concentrations are higher than the applicable dissolved AWQC, it is likely that the observed mortality in these *in situ* tests was due to the elevated Cd and Zn concentrations.

Lethality of rainbow trout *in Situ* in live box exposures was also determined by the U.S. EPA in September 1986 (Hornig et al., 1988). Rainbow trout were placed in cages at eight locations along the SFCDR, at one location in the NFCDR, and in the main stem CDR. Mortality after 96 hours of exposure in the SFCDR ranged from 40-100% downstream of the confluence of Canyon Creek to 0% in SFCDR headwaters (upstream of the confluence of Canyon Creek). Water hardness was not measured. Cd and Zn concentrations measured in the SFCDR downstream of Canyon Creek ranged from 15 to 29 µg/L and from 1480 to 2800 µg/L, respectively. *In situ* tests with similar results were did by the U.S. EPA in June 1973, July 1979, September 1979, and September 1982 at multiple stations along the SFCDR (Hornig et al., 1988).

Woodward and Farag *(1995)* observed 100% mortality within 72 hours in westslope cutthroat trout held in cages exposed to 70% NFCDR and 30% SFCDR water. Subsequent *in situ* caging experiments with westslope cutthroat trout and rainbow trout resulted in 100% mortality in fish held in the SFCDR, 97% mortality in fish held at the confluence of the NFCDR and the SFCDR, and no mortality in fish held for 96 hours in the NFCDR (Woodward and Farag, 1995). The hardness of the water was not measured. Metal concentrations in the SFCDR at approximately the same time as the caging study ranged from 8.5 to 9.3 µg Cdl, 25.5 to 31.8 µg Pb/L, and 1.75 to 1.93 mg Zn/L (Woodward and Farag, 1995).

Woodward et al. (1999) did *in situ* caging experiments with westslope cutthroat trout at sites in the SFCDR and the St. Regis River selected as having similar habitats. Mortality was 30% at site SF24 and 100% at sites SF0, SF8, and SF16 after 96 hours of exposure (Table 3.2.1.2-4). Mortality was 0% at SF32 and at all the (control) paired St. Regis River sites. Mean metal concentrations at the SF0, SF8, and SF16 sites ranged from 7.1 to 12 µg Cd/L, 12 to 43 µg Pb/L, and 805 to 2440 µg Zn/L (Woodward et al., 1999). Hardness varied from 21 to 188 mg/L along the SFCDR from sites SF0 to SF32. When metal concentrations at SF0, SF8 and SF16 are normalized to a hardness of 50 mg/L, they range from 1.94 to 5.01 µg Cd/L, 2.84 to 17.5 µg Pb/L, and 357 to 794 mg Zn/L (Table 3.2.1.2-4). The normalized Cd concentrations where 100% mortality was observed are similar to the existing dissolved AWQC for Cd.

Table 3.2.1.2-1
Site-Specific Acute Lethality Data for Cutthroat and Rainbow Trout Exposed Individually to Cd, Pb, and Zn In Waters Collected from the CdA River Basin (comparisons to AWQC based on dissolved metal concentrations)

Site	Species	Metal	Hardness (mg/L)	Lowest Effect Concentration (µg/L)[a]	Hardness Normalized Lowest Effect Concentration (µg/L)[b]	% Mortality	Source
SFCDR water (hatchery fish)	Cutthroat	Cd	21	0.5	1.25	86	EVS, 1996b
	Rainbow		21	0.5	1.25	71	
	Cutthroat	Pb	21	24-51	65.5-139	20-40	
	Rainbow		21	97	265	35	
	Cutthroat	Zn	18	55	132	35	
	Rainbow		18	55	132	30	
Little North Fork water (hatchery fish)	Rainbow	Cd	21	0.9	2.25	60	EVS, 1997b
	Rainbow	Pb	21	100	273	30	
Summary Data		**Cd**	**21**	**0.5-0.9**	**1.25-2.25**	**60-86**	**[Cd AWQC = 2.0]**
		Pb	**21**	**24-100**	**65.5-273**	**20-40**	**[Pb AWQC = 30]**
		Zn	**18**	**55**	**132**	**30-35**	**[Zn AWQC = 65]**

a. Effect concentration with greater than 20% mortality. Expressed as dissolved metal concentration.

b. Data were normalized to a hardness of 50 mg/l, using the equation C(x) = C(h) x AWQC(x)/AWQC(h), where C(x) is the normalized concentration, C(h) is the concentration at the measured hardness, AWQC(x) is the dissolved AWQC at the normalized hardness level and AWQC(h) is the dissolved AWQC at the measured hardness.

Table 3.2.1.2-2
Site-Specific Acute Lethality Data for Rainbow Trout Exposed *in situ* to a Metals Mixture in CdA River Basin Site Waters

Location (river mile)	Hardness	Metal Concentration at Effect Level (µg/L)			Effect (% mortality)
		Cd	Pb	Zn	
SFCDR near Elizabeth Park (RM 9)	84	12	21	1800	100
	80	6	13	2190	100
	67	10	≤5	1230	100
SFCDR near Bunker Creek (RM 6.8)	104	10	≤19	2200	100
	88.7	7	25	2760	100
	74.4	10	≤5	1490	100
SFCDR near Government Creek (RM 5)	168	11	≤19	2400	100
	141	7	≤25	3000	100
	78.5	13	9	1710	100
SFCDR near Pine Creek (RM 2.2)	120	8	≤19	2100	100
	121	6	18	2780	100
	73.8	9	≤5	1480	100
NFCDR near Enaville (RM 0.2)	18	≤2	31[a]	9.40	30
	17.4	≤4	≤5	≤20	55
	17.1	≤4	≤5	30	40
Range	**18-168**	**≤2-13**	**≤5-31**	**9.4-3000**	**30-100**

a. Potential residual lead contamination on ICP torch.

Source: Data from Dames and Moore, 1989.

Table 3.2.1.2-3
Site-Specific Acute Lethality Data for Rainbow Trout Exposed *in situ* to a Metals Mixture in CdA River Basin Site Waters
(metal concentration normalized to hardness 50 mg/L)

Location (river mile)	Hardness	Metal Concentration at Effect Level (μg/L)			Effect (% mortality)
		Cd	Pb	Zn	
SFCDR near Elizabeth Park (RM 9)	50	6.86	11.9	1160	100
	50	3.64	7.65	1470	100
	50	7.14	ND	963	100
SFCDR near Bunker Creek (RM 6.8)	50	4.55	ND	1180	100
	50	3.78	13.1	1690	100
	50	6.45	ND	1060	100
SFCDR near Government Creek (RM 5)	50	2.93	ND	857	100
	50	2.26	ND	1240	100
	50	7.88	5.4	1170	100
SFCDR near Pine Creek (RM 2.2)	50	3.08	ND	996	100
	50	2.31	6.84	1310	100
	50	5.8	ND	1060	100
NFCDR near Enaville (RM 0.2)	50	ND	93[b]	22.6	30
	50	ND	ND	ND	55
	50	ND	ND	75.0	40
Range in SFCDR Tests Only	**50**	**2.26-7.88**	**5.4-13.1**	**857-1470**	**100**
Acute Dissolved AWQC		**2.0**	**30**	**65**	

a. Data were normalized to a hardness of 50 mg/L, using the equation C(x) = C(h) x AWQC(x)/AWQC(h), where C(x) is the normalized concentration, C(h) is the concentration at the measured hardness, AWQC(x) is the dissolved SWQC at the normalized hardness level and AWQC(h) is the dissolved AWQC at the measured hardness.

b. Potential residual lead contamination on ICP torch.

ND = not done.

Source: Data from Dames and Moore, 1989.

Table 3.2.1.2-4
Acute Lethality in Westslope Cutthroat Trout in Water Collected from Various Locations along the SFCDR

Location (river mile)	Hardness	Metal Concentration at Effect Level (µg/L)			Effect (% mortality)
		Cd	Pb	Zn	
Site Water at Nominal Water Hardness					
SFCDR (SF-0)	188	12	12	2440	100
SFCDR (SF-8)	189	8.2	43	1100	100
SFCDR (SF-16)	69	7.1	25	805	100
SFCDR (SF-24)	76	0.91	2.9	154	30
SFCDR (SF-32)	21	0.06	0.43	6.7	0
Range	21-189	0.06-12	0.43-43	6.7-2440	1-100
Site Water Normalized to Hardness of 50 mg/L[a]					
SFCDR (SF-0)	50	2.85	2..84	794	100
SFCDR (SF-8)	50	1.94	10.1	357	100
SFCDR (SF-16)	50	5.01	17.5	613	100
SFCDR (SF-24)	50	0.58	1.83	108	30
SFCDR (SF-32)	50	0.15	1.14	14	0
Range at SF-0, SF-8, and SF-16 Only		**1.94-5.01**	**2.84-17.5**	**357-794**	
Acute Dissolved AWQC		**2.0**	**30**	**65**	

a. Metal concentrations were normalized to a hardness of 50 mg/L, using the equation C(x) = C(h) x AWQC(x)/AWQC(h), where C(x) is the normalized concentration, C(h) is the concentration at the measured hardness, AWQC(x) is the dissolved SWQC at the normalized hardness level and AWQC(h) is the dissolved AWQC at the measured hardness.

Source: Woodward et al., 1999.

-Benthic Invertebrates (Don)

3.4.2 Acute Lethality Testing with Benthic Invertebrates

EVS (1 996b, 1 997b, 1998) did site-specific toxicity tests with benthic invertebrates collected from the SFCDR. Various species were individually exposed to either Cd, Pb, or Zn in LNF water. Invertebrates collected from the SFCDR were relatively tolerant of Cd, Pb and Zn exposures (Table 3.2.1.2-5). Effects concentrations normalized to a hardness of 50 mg/L were at least one to two orders of magnitude greater than AWQC values.

Results from these site-specific toxicity tests suggest that toxicity to Coeur d'Alene invertebrates occurs at metal concentrations well above ALC values. EVS used invertebrates collected from the SFC DR upstream of Mullan, and exposed the invertebrates to SFCDR water spiked with Cd, Zn, or Pb. However, the thresholds produced from these tests may not be the most sensitiv thresholds for Coeur d'Alene basin invertebrates for the following reasons:

The test results are not indicative of toxicity to metal-sensitive invertebrate species. For example, of the five invertebrate species used in Pb toxicity testing, the most sensitive species was the mayfly *Baetis tricaudatus* (EVS, 1997). Although many mayfly species are sensitive to metals, *Baetis* are known to be relatively tolerant of metal toxicity (Beltman et al., 1999). In fact, *Baetis tricaudatus* was one of the first species to recognize the SFC DR in the early 1 970s, when only a few invertebrate species could survive in the river (Stokes and Ralston, 1972; Savage and Rabe, 1973; Funk et al., 1975). Therefore, the tests most likely did not use species representative of metal-sensitive invertebrates.

The tests used invertebrates collected from the South Fork Coeur d'Alene River in areas potentially downstream of mining activity. Therefore, the organisms used in the tests may have been preselected for metal tolerance.

Several of the tests did not show a consistent dose-response relationship, making their interpretation difficult.

In addition to site-water *in situ* toxicity tests with rainbow trout in the SFCDR, Dames and Moore (1989) also did site-specific 7-day toxicity tests with *Ceriodaphnia dubia* with site water collected from the same locations on the SFC DR. Ceriodaphnia were exposed to 0, 0.1, 0.3, 1, 1.5,3.6, 13,25, 50, and 100% site water mixed with clean laboratory water (as appropriate) under controlled laboratory conditions. LC_{50} values ranged from 0.1 to 6.1% site water at water hardness ranging from 67 to 168 mg/L (Table 3.2.1.2-6). When normalized to a water hardness of 50 mg/L, metal concentrations at the LC_{50} effect ranged from 0.11 to 0.36 µg Cd/L, from 0.03 to 0.46 µg Pb/L, and from 19.3 to 95.2 µg Zn/L (Table 3.2.1.2-7). These concentrations fall below the dissolved AWQC for Cd and Pb and are within a factor of 2 (both above and below) the dissolved Zn AWQC. No mortality was observed in 100% NFCDR site water (Dames and Moore, 1989). These acute toxicity results suggest that the toxicity of a mixture of Cd, Pb, and Zn is greater than the toxicity based on single metal exposures and highlight that the site water collected from the SFCDR is acutely lethal to zooplankton at mixed metal concentrations at or near the applicable AWQC.

Table 3.2.1.2-5
Site-Specific Acute Lethality Data for Invertebrate Species Exposed Individually to Cd, Pb, and Zn In Waters Collected from the CdA River Basin (comparisons to AWQC based on dissolved metal concentrations)

Site	Species	Metal	Hardness (mg/L)	Lowest Effect Concentration (µg/L)[a]	Hardness Normalized Lowest Effect Concentration (µg/L)[b]	% Mortality	Source
Organisms collected from SFCDR near Shoshone Park (tested in Little North Fork water)	Baetis	Cd	21	73	183	45	EVS, 1996b
	Rhithrogena	Pb	18	745	2240	30	
	Gyraulus		21	480-562	1309-1533	20-72	EVS, 1997b
	Baetis		21	145-332	396-906	14-32	
	Baetis	Zn	14	784-1193	2320-3250	14-29	EVS, 1996b, 1997b
	Hydropsyche		14	1490	4410	31	
	Sweltsa		18	1530	3670	25	
	Gyraulus		14	784-999	2320-2950	20-40	
	Rhithrogena		14	999-2260	2950-6690	25-35[c]	
Organisms collected drom SFCDR. (Tested in Little North Fork water)	Gyraulus[d]	Pb	19	146	438	27	EVS, 1998
	Rhithrogena[d]		19	146	438	27	
	Sweltsa[d]		19.5	144-153	432-458	20-47	
	Drunella[d]		19.5	153-267	458-802	20-33	
Summary Data		**Cd**	**21**	**73**	**183**	**45**	**[Cd AWQC = 2.0]**
		Pb	**18-20.5**	**144-745**	**396-2240**	**14-72**	**[Pb AWQC = 30]**
		Zn	**14-18**	**784-2260**	**2320-6690**	**14-40**	**[Zn AWQC = 65]**

a. Effect concentration with greater than 20% mortality.

b. Normalized to a hardness of 50 mg/l, using the equation C(x) – C(h) x AWQC(x)/AWQC(h), where C(x) is the normalized concentration, C(h) is the concentration at the measured hardness, AWQC(x) is the dissolved AWQC at the normalized hardness level and AWQC(h) is the dissolved AWQC at the measured hardness.

c. All concentrations greater than 999 but less than 2360 had ≤20% mortality.

d. Flow-through toxicity tests.

Table 3.2.1.2-6
Site-Specific 7-d Lethality Data for *Ceriodaphnia dubia* Exposed to a Metals Mixture in CdA River Basin Site Waters

Location (river mile)	% Site Water	Hardness	Metal Concentration at Effect Level (µg/L)			Effect (% mortality)
			Cd	Pb	Zn	
SFCDR near Elizabeth Park (RM 9)	2.0	84	0.24	0.42	36	50
	6.1	80	0.37	0.79	133	50
	5.1	67	0.51	0.13	62.7	50
SFCDR near Bunker Creek (RM 6.8)	0.1	104	0.25	0.44	37.4	50
	1.9	88.7	0.32	0.70	118	50
	3.7	74.4	0.38	0.09	46.7	50
SFCDR near Government Creek (RM 5)	0.1	168	0.42	0.73	62.9	50
	1.9	141	0.46	0.99	167	50
	1.7	78.5	0.3	0.07	36.7	50
SFCDR near Pine Creek (RM 2.2)	3.9	120	0.5	0.88	75.5	50
	5.6	121	0.55	1.2	202	50
	1.9	73.8	0.22	0.05	27	50
Range	**0.1-6.1**	**67-168**	**0.22-0.55**	**0.05-1.2**	**27-202**	**50**

a. Metal concentrations were determined by multiplying the metal concentration in 100% site water by the % site water corresponding to the effect measured. In cases where the total metal concentration was below detection, one half of the detection limit was used.

Source: Data from Dames and Moore, 1989.

Table 3.2.1.2-7
Site-Specific 7-d Lethality Data for *Ceriodaphnia dubia* Exposed to a Metals Mixture in CdA River Basin Site Waters (metal concentrations normalized to hardness 50 mg/L)

Location (river mile)	% Site Water	Hardness	Metal Concentration at Effect Level (μg/L)			Effect (% mortality)
			Cd	Pb	Zn	
SFCDR near Elizabeth Park (RM 9)	2.0	50	0.14	0.23	23.2	50
	6.1	50	0.22	0.46	89.5	50
	5.1	50	0.36	0.09	49.1	50
SFCDR near Bunker Creek (RM 6.8)	0.1	50	0.11	0.19	20.1	50
	1.9	50	0.17	0.37	72.7	50
	3.7	50	0.25	0.06	33.3	50
SFCDR near Government Creek (RM 5)	0.1	50	0.11	0.19	22.5	50
	1.9	50	0.15	0.32	69.2	50
	1.7	50	0.18	0.04	25.1	50
SFCDR near Pine Creek (RM 2.2)	3.9	50	0.19	0.33	35.8	50
	5.6	50	0.21	0.46	95.2	50
	1.9	50	0.14	0.03	19.3	50
Range	**0.1-6.1**	**50**	**0.11-0.36**	**0.03-0.46**	**19.3-92.5**	**50**
Acute Dissolved AWQC		**50**	**2.0**	**30**	**65**	

a. Metal concentrations were determined by multiplying the metal concentration in 100% site water by the % site water corresponding to the effect measured. In cases where the total metal concentration was below detection, one half of the detection limit was used. The data were then normalized to a hardness of 50 mg/L, using the equation $C(x) = C(h) \times AWQC(x)/AWQC(h)$.

Source: Data from Dames and Moore, 1989.

- Terrestrial Plants **(Brad/Steve)**
- Birds, Mammals, and Amphibians **(Brad/Steve)**

3.2.1.3 Site-specific Field Surveys

- ——————Fish **(Don)**

Fish population estimates have made based on sampling in reference and assessment areas in CSM Units 1 and 2 by R2 Resource Consultants (R2) (R2 Resource Consultants, 1995a, 1996a, 1997a) and Stratus Consultants, Inc. (Stratus, 1999d) (electronic data provided by R2 Resource Consultants, and summary report by Stratus, 1999d), and by the State of Idaho as part of the Benificial Uses Reconnaisance Program (BURP) (raw data forms provided by Geoff Harvey, IDEQ). The fish population data collected by R2 and Stratus was based on multiple-pass electro-shocking, while the data collected by the State of idaho was generally based on single pass electro-shocking. The BURP data were converted to estimated populations equivalent to multiple pass estimated using the conversion of Armour, et al. (1983).

: Metric scoring is based on the estimated trout density (including native west-slope cutthroat, and introduced rainbow, brook and brown trout), expressed in fish per square meter (m^2), and the presence or absence of sculpins. Sampling was did throughout the SFCDR, its tributaries, and on the St. Regis River at locations selected and distributed to provide a representative population estimate (Reiser 1999, Stratus Consulting 1999a).

A trout density of 0.1 fish per square meter was selected as a breakpoint between the good and moderate metric ranking based on evaluation of fish populations in least impacted reference streams. The presence or absence of sculpins is also selected as a metric breakpoint, on the basis of their sensitivity to metals pollution and habitat disturbance. Adult home ranges of sculpins are generally less than 150 meters, and often much less (<50 meters). As such, they are subject to localized habitat quality issues and their absence is indicative of degraded habitat (Hendricks 1997, Reiser 1999).

Metric score 3 (excellent): Trout density >0. 11m^2, sculpins present.

Metric score 2 (good): Trout density >0, <0. 11m^2, sculpins present.

Metric score 1 (medium): Trout present, sculpins absent.

Metric score 0 (poor): No fish present.

Trout were present in all reference stream locations sampled (Table 3.2.1.3-1). Metric scores for reference stream segments were 2 or 3, with the exception of one sampling event in 1994 on the lower Little North Fork when sculpins were not captured and the metric score was 1. Sculpins were captured at that location in 1995, and the metric score was 2.

Metric scores for fish were generally from 0 to 2 in the assessment areas, with some notable exceptions: Beaver Creek and the upper South Fork of the Coeur d'Alene River (the Morning District near Mullin, and upstream), where metric scores of 2 to 3 were observed (Table 3.2.1.3-2) had scores comparable to, or better than the associated reference areas. The BURP assessment locations in Beaver Creek are well downstream of the Carlisle Millsite, while the elevated concentrations of metals in Beaver Creek are above and just below the Carlisle Millsite, so the scores from Beaver creek may not reflect conditions in the most affected area.. The metric scores for fish indicate that fish populations in most assessment areas are reduced, or absent in some places, compared to reference streams. The most seriously affected areas are Canyon Creek, Segment 5, and Ninemile Creek, Segments 1, 2, and 4, where fish were not captured by electroshocking.

Comparable fish population data are not available from CSM Units, 3, 4, and 5; due in part to the large size of the rivers and lakes in those CSM Units. However, studies of the Spokane River (CSM Unit 5) have indicated the presence of good rearing habitat for trout (Kleist, 1987) with limited spawning habitat (Johnson, 1997). Because of the size of the Spokane River, population density has been measured (Bennett and Underwood, 1988) using electro-shocking methods that differ somewhat from those used in the upper Coeur d'Alene basin. Population estimates were stated as 19,029 trout per their 7.9 km study reach (presumably excluding fry). Assuming a width of 50 to 75 m, that would be 0.032 to 0.048 trout per square meter (Bennett and Underwood report 5.2g per square meter, but do not provide the basis for determining how many square meters are present in their study aresa). In any case the metrics used to evaluate the upper basin streams would not apply in the much larger Spokane River. Bennett and Underwood (1988) estimated that the annual mortality of trout in their Spokane River study area was about 70 percent, with fishing mortality contributing up to 10 percent. The remainder of the mortality was attributed to post-spawning mortality and effects of metals.

——————Benthic Macro-Invertebrates **(Don)**

Data were obtained from macroinvertebrate sampling from CSM Units 1 and 2 done in 1998 in the SFCDR, NFCDR, St. Joe River, and tributaries of these systems for the BURP project (IDEQ, 1999) and by – Resource Consultants in 1996 (R2 Resource Consultants 1996a; Stratus Consulting 1999e, 1999f). Counts based on less than three replicates per location per sampling event were not included in this evaluation because of low certainty in the results. An additional source of data being from studies done by the U.S. Bureau of Mines for the U.s. Forest Service (McNary, et al., 1995).

Species richness of the benthic macro-invertebrate community, expressed in the number of taxa collected at a sampling location, is one of several macro-invertebrate metrics used to indicate the ecological condition of Pacific Northwest watersheds (Bennet and Fisher 1989; Hoiland and Rabe 1991;R2 Resources Consultants 1997c; Stratus Consulting 1999d). Usually species richness is evaluated in conjunction with these other metrics to form an evaluation of ecological conditions. However, different sampling methods were used in the three data sources available for this analysis, which invalidated comparison of the majority of the metrics. Species richness data was comparable, and in general, higher macro-invertebrate species richness is indicative of better ecological condition in Pacific Northwest watersheds (Hoiland and Rabe 1991).

Two separate sets of macro-invertebrate metric scores were developed CSM Unit 01 and 02 segments from species richness counts taken from Rosgen (1994) type B and Rosgen type C reference streams. For each set, the mean number of taxa and the standard deviation were calculated. Two standard deviations below the mean was established as the breakpoint between "good" and "medium" conditions. Eight or fewer macro-invertebrate species was established as the breakpoint between "medium" and "poor" conditions, based on observed numbers of metals and disturbance tolerant taxa (e.g., ***Chironomidae***) in degraded areas. The numbers of taxa and summary statistics for the numbers of taxa from Rosgen type B and type C streams are shown in Tables3.2.1.3-3 and 3.2.1.3-4, respectively.

Numbers of taxa for the arrayed reference ard assessment areas are shown on Table 3.2.1.3-5. The reference stream sections all have metric ratings of 3, as do some of the assessment stream sections (Table 3.2.1.3-5). Assessment stream sections with metric ratings of 1 (poor) included lower Canyon Creek (Segment 05) Lower Moon Creek (Segment 02), Upper Ninemile Creek (Segment 01-location uncertain), and the South Fork of the Coeur d'Alene River near Enaville and near Smelterville (CSM Unit 2, Segment 2).

In general, the metric for taxa richness indicate that more assessment stream sections are comparable to reference stream sections than was indicated by the metrics for fish (Table 3.2.1.3-2).

Benthic invertebrate communities were studied in Lake Coeur d'Alene by Winner (1972) and Ruud (1996). Winner (1972) observed a strong dominance by Chironomids (51-75%) and Oligochaetes (26-49%), and species of the subfamily Chironominae (dominated by *Microspecta* sp. and *Chronimus* sp.) comprised the majority (73%) of the Chironomids. However, Winner (1972) did not find a relationship between sediment metal concentrations (e.g., Zn concentrations up to 7,000 mg/kg) and the distribution of Chironomids or Oligochaetes.

Ruud (1996) detected significant differences in the proportions of dominant taxa of profundal communities (20 m to 40 m depths), and sublittoral communities (5 m to 10 m depths) between Lake Coeur d'Alene and Priest Lake, Idaho, an oligotrophic lake of similar size, flow, and parent geology. Profundal communities of Priest Lake were dominated by Chironominae (*Microspectra* sp. and *Chironomus* sp.) and Sphaeriidae, whereas Lake Coeur d'Alene profundal communities were dominated by Nematophora, Tricladidae, and Oligochaetae. Sublittoral communities in Priest Lake were dominated by Chironominea and Tanypodinae, whereas Lake Coeur d'Alene sublittoral communities were dominated by Amphipoda, Isopoda, Tanypodinae, and Oligochaetae. Ruud (1996) observed a negative correlation between Zn concentrations in water and total abundance, total biomass, taxa richness, and mean diversity, as well as between Pb concentrations in water and total abundance and total biomass. However differences in abundance of Chironominea and total abundances and biomass of benthic invertebrates did not show a clear relationship to metals concentrations, especially in deeper water where metals concentrations are generally higher.

- Terrestrial Plants **(Brad/Steve)**
- Amphibians **(Brad/Steve)**
- Birds **(Brad/Steve)**
    - Mammals **(Brad/Steve)**

Dana

3.2.2 Biological and Physical Stressor-Response/Condition Analysis

(This subsection will describe the approach for assessing the risk from the biological and physical stressors that are associated with mining-related hazardous substances. Assessment approaches will be defined for the set of measures of ecosystem and receptor characteristics described in Table 2-2 of the 11/99 Draft Problem Formulation Document. Assessment approaches will also be defined for biological field survey results that will serve as measures of effect [i.e., fish diversity and abundance, riparian vegetation diversity and abundance, benthic macroinvertebrate diversity and abundance]. A narrative description of the assessment methods and supporting tables will be provided. For some measures, the assessment approach is based upon a common and widely accepted method that utilizes a universally acceptable baseline. For other measures, the baseline is represented by local reference conditions. In those instances, the raw data and basis for the approach will be defined.)

Table 3 - __. Values of Bank Stability in Riverine Reference Areas

Table 3 - __. Descriptive Statistics for Bank Stability in Riverine Reference Areas

Table 3 - __. Values of Substrate Composition and Mobility Riverine Reference Areas

Table 3 - __. Descriptive Statistics for Substrate Composition and Mobility of Riverine Reference Areas

Table 3 - __. Values of Large Woody Debris in Riverine Reference Areas

Table 3 - __. Descriptive Statistics for Large Woody Debris in Riverine Reference Areas

Table 3 - __. Values of Selected Fish Population Characteristics in Riverine Reference Areas

Table 3 - __. Descriptive Statistics for Selected Fish Population Characteristics of Riverine Reference Areas

Table 3 - __. Values of Selected Benthic Macroinvertebrate Population Characteristics in Riverine Reference Areas

Table 3 - __. Descriptive Statistics for Selected Benthic Macroinvertebrate Population Characteristics of Riverine Reference Areas

Table 3 - __. Values of Selected Vegetative Characteristics of Riparian Reference Areas

Table 3 - __. Descriptive Statistics for Selected Vegetative Characteristics of Riparian Reference Areas

3.2.3 Stressor-Response Profile

(Text to provide a summary of the stressors in each category including description of observed ecological effects [field studies] that will be used to evaluate potential risk/impact in the risk characterization.)

Brad/Trudy/Don 3.2.3.1 Chemical (this section should be brief – should refer back to section 3.2.1)

-summary of stressors

-results of field studies/surveys

Dana 3.2.3.2 Biological

(This subsection will provide a narrative description and table summarizing the biological stressor-response profiles.)

Table 3 - __. Summary of Biological Stressor-Response Profiles. (a conceptual draft format for the table is provided below)

Table 3 - __. Summary of Biological Stressor-Response Profiles (conceptual draft – values are fictitious)

Applicable Habitat and CSM Unit	Measure	Little or No Degradation	Moderate Level of Degradation	High Level of Degradation
Riparian – CSM Unit 1	Macroinvertebrate Species Richness	> 11 species present	< 11 and > 8 species present	< 8 species present

Dana 3.2.3.3 Physical

(This subsection will provide a narrative description and table summarizing the biological stressor-response profiles.)

Table 3 - __. Summary of Physical Stressor-Response Profiles. (a conceptual draft format for the table is provided below)

Table 3 - __. Summary of Physical Stressor-Response Profiles (conceptual draft – values are fictitious)

Applicable Habitat and CSM	Measure	Little or No Degradation	Moderate Level of Degradation	High Level of Degradation

Unit				
Riparian – CSM Unit 1	% Bare Ground	< 22%	> 22% and < 50%	> 50%

4.0 Risk Characterization

4.1 Risk Estimation (describes nature and magnitude of risks for each available line of evidence)

4.1.1 - Chemical Risks

4.1.1.1 - Single-chemical Toxicity Data (evaluates both internal and external exposure as available data support)
- Fish **(Don)**
- Benthic Invertebrates **(Don)**
- Aquatic Plants **(Don)**
- Amphibians **(Lisa)**
- Soil Invertebrates **(Lisa)**
- Terrestrial Plants **(Lisa)**
- Microbial Processes **(Lisa)**
- Birds and Mammals
    - External Exposures **(Trudy)**
    - Internal Exposures **(Brad)**

4.1.1.2 - Site-specific Ambient Media Toxicity Tests **(Don/Brad - much of these data may already be incorporated into section 4.1.1.1)**

4.1.1.3 - Site-specific Biological Surveys
- Fish **(Don)**
- Benthic Invertebrates **(Don)**
- Aquatic plants **(Don)**
- Amphibians **(Brad/Steve/Trudy)**
- Terrestrial Plants **(Brad/Steve/Trudy)**
- Birds and Mammals **(Brad/Steve/Trudy)**

4.1.2 - Physical/biological Risks **(Dana)**

4.2 Risk Description (AKA Weight of Evidence - summarizes and weighs available evidence for each receptor group - by location and habitats within that area)

4.2.1 Fish **(Don)**
4.2.2 Benthic invertebrates **(Don)**
4.2.3 Aquatic plants **(Don)**
4.2.4 Amphibians **(Lisa/Steve/Trudy)**
4.4.5 Terrestrial plants **(Lisa/Steve/Trudy)**
4.2.6 Soil invertebrates **(Lisa/Steve/Trudy)**
4.2.7 Microbial processes **(Lisa/Steve/Trudy)**
4.2.8 Birds **(Brad/Trudy/Steve)**
4.2.9 Mammals **(Brad/Trudy/Steve)**

4.2.10 - Summary of risk characterization by location and habitat type (this will also incorporate all of Dana's physical and biological measures analyses) **(All)**

All 4.3 Uncertainty Analysis

(This section will describe the uncertainties and limitations encountered in each of the major sections of the EcoRA [i.e., problem formulation, analysis, risk characterization]. The uncertainties and limitations will be discussed qualitatively and where possible they will be characterized as to their potential over-all effect on the conclusions [e.g., may result in an overestimation of risk or may result in an underestimation of risk]. Sources of uncertainties and limitations may include, but are not limited to, the following: availability of data for specific media in some watersheds, quality of analytical data, availability of information concerning biological and/or physical attributes within a given watershed, lack of site-specific information on exposure factors for representative species, and assumptions used in the quantitative and qualitative estimates of risk.)

4.3.1 Problem Formulation

4.3.2 Analysis

4.3.2.1 Exposure Characterization

4.3.2.2 Ecological Effects Characterization

4.3.3 Risk Characterization

4.3.3.1 Risk Estimation

4.3.3.2 Risk Description

5.0 Conclusions and Ecological Remedial Action Objectives

All 5.1 Conclusions

(This section will describe the conclusions drawn from quantitative and qualitative evaluations of available chemical, biological, and physical data for the Coeur d'Alene Basin based on a weight-of-evidence approach.)

5.2 Ecological Remedial Action Objectives

(Remedial action objectives are broad enough to include FS linkages.)

Brad/Don/Trudy -Ecological Preliminary Remedial Goals (PRGs) for Chemical Stressors

Dana -Summary of Ecological Status Ranking and Ecological Goals

(This section will summarize the linkage of the ecological status ranking and ecological objectives to the FS - described in detail in Appendix E..)

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Appendices

Appendix A - Analytical Data (electronic)
Appendix B - Data Qualification Procedures for TDMS Database - URS Corp.
Appendix C - Cumulative Distribution Functions for Representative Receptors
Appendix D – Descriptions of Studies Used to Calculate NOAELs and LOAELs
Appendix E -Ecological Status Ranking and Ecological Objectives
Appendix F - **[[From URSG]]**
Others as Needed